Published in final edited form as:

Pediatr Infect Dis J. 2018 July ; 37(7): e178–e184. doi:10.1097/INF.0000000000001846.

Race, Income, and Insurance Status Affect Neonatal Sepsis Mortality and Healthcare Resource Utilization

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Abstract

Background—Socioeconomic disparities negatively impact neonatal health. The influence of sociodemographic disparities on neonatal sepsis are understudied. We examined the association of insurance payer status, income, race, and gender on neonatal sepsis mortality and healthcare resource utilization.

Methods—We used the Kid's Inpatient Database (KID), a nationwide population-based survey from 2006, 2009, and 2012. Neonates diagnosed with sepsis were included in the study. Multivariable logistic regression (mortality) and multivariable linear regression (length of stay (LOS) and total hospital costs) were constructed to determine the association of patient and hospital characteristics.

Results—Our study cohort included a weighted sample of 160,677 septic neonates. Several sociodemographic disparities significantly increased mortality. Self-pay patients had increased mortality (Odds Ratio (OR) 3.26 [95% CI 2.60-4.08]), decreased LOS (-2.49 ± 0.31 days, $p < 0.0001$) and total cost ($-\$5015.50 \pm 783.15$, $p < 0.0001$) compared to privately insured neonates. Additionally, low household income increased odds of death compared to the most affluent households (OR 1.19 [95% CI 1.05-1.35]). Moreover, Black neonates had significantly decreased LOS (-0.86 ± 0.25 , $p = 0.0005$) compared to White neonates.

Conclusions—This study identified specific socioeconomic disparities that increased odds of death and increased health care resource utilization. Moreover, this study provides specific societal targets to address to reduce neonatal sepsis mortality in the United States.

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Declaration of interests: The authors certify that they have no affiliations or involvement in any organization or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

Keywords

neonatal sepsis; neonatal mortality; mortality; health disparities; race; costs

INTRODUCTION

From 1990-2015 the Millennium Development Goals (MDGs), specifically MDG-4, targeted a two-thirds reduction in under-5 mortality rate (U5MR). Although the global community reduced U5MR 53% during this 25 year period, the overall MDG-4 target was not achieved.[1] The United States (US) only achieved a U5MR reduction of 36% and a neonatal mortality reduction of only 33%.[2] Neonatal deaths account for greater than 40% of the U5MR with neonatal sepsis being the 5th leading cause (globally and in the US) contributing 15% of all neonatal deaths worldwide.[2,3]

Neonatal sepsis is a systemic infection that occurs in neonates less than 28 days of life. The incidence of neonatal sepsis ranges from 1-170/1000 live births with the highest incidence in very-low-birth-weight infants (VLBW, birth weight <1500 g).[4] Classically, neonatal sepsis is defined as early-onset sepsis or late-onset sepsis and is determined by the timing of diagnosis. Early-onset sepsis (symptoms development less than 72 hours of life in the neonatal intensive care unit (NICU) or < seven days in term-neonates) is caused by maternally transmitted pathogens and is associated with biological factors such as prematurity, premature and prolonged rupture of membranes, and maternal infections. and non-biological factors such as low socioeconomic status.[4–7] Occurring most frequently between 10 to 22 days of life, late-onset sepsis, is associated with nosocomial or community acquired infections, prolonged hospitalization, use of central venous catheters, parenteral nutrition, and prematurity.[8,9] The Institute of Medicine (IOM) report, *Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care* focused national attention on the expanding gap in care among disadvantaged people.[10,11] Historically, infant mortality (all-cause) in non-Hispanic Blacks has been more than double that for non-Hispanic Whites and Hispanics.[12] A national population study looking at all-cause neonatal mortality by Socioeconomic Deprivation Index found that the most deprived neonates experienced 43% higher relative risk of mortality.[13] Further, sociodemographic and healthcare disparities negatively impact the incidence of neonatal sepsis and mortality. In one US population-based study, Black preterm patients with early-onset sepsis had the highest incidence of 5.14 cases/1000 live births and a mortality rate of 24.4%.[14] Despite the tremendous impact of neonatal sepsis, there are few large population-based studies accessing the contributing factors that contribute to mortality and healthcare resource utilization. We hypothesize that racial and socioeconomic factors adversely influence mortality and healthcare resource utilization in neonatal sepsis.

METHODS

Study Design and Setting

We conducted a retrospective cross-sectional analysis of neonates with sepsis using the Healthcare Cost and Utilization Project's (HCUP) Kids Inpatient Database (KID) for the

years 2006, 2009, and 2012.[15] The KID is the United States' largest publicly available all-payer pediatric inpatient care database collected by the Agency for Healthcare Research and Quality and is collected and reported every three years.[16] Using discharge weights from the American Hospital Association universe, the KID allows for national estimates. Nationally available deidentified data was used for this study and it was exempt from Institutional Review Board approval by the University of Texas Medical Branch.

Study Population

From all pediatric discharges (N=9,734,252), hospitalizations for neonates with sepsis were identified in a multi-step process (Figure 1). Neonatal discharges were determined by age at admission (<28 days of life), neonate indicator variable, and by any diagnosis code V3000-V3901 representing an in-hospital birth and without an admission source from another healthcare facility or home. Neonates with sepsis were identified using the following ICD-9-CM codes: 771.81 (sepsis of the newborn), 670.2 (puerperal sepsis), 995.91 (sepsis), 995.92 (severe sepsis), and 785.52 (septic shock). Due to the wide variety of ways in which data was reported, ICD-9 diagnosis provided the largest and most accurate cohort of patients. We excluded patients who were (i) transferred in or came from home after birth, (ii) transferred out of the hospital to another acute care facility, or (iii) with missing patient or hospital characteristics.

Patient Characteristics

Patient characteristics included race, sex, primary payer, median household income, severity and birthweight. Race was categorized as White, Black, Hispanic and other (Asian or Pacific Islander, Native American, or other). Race was self-reported. [16] Primary payer was categorized as Medicaid, private, self-pay (self-pay or uninsured) and other (no charges or other sources); reports and publications can provide the necessary background to understand the U.S. Healthcare pay system.[17] Median household income for patient ZIP code was reported in quartiles (Q1-lowest income quartile, Q4-highest income quartile). Quartiles were preferred over monetary values for median household income due the changes over the reported years from economic and inflationary issues. Severity of illness (SOI) was classified using the All Patient Refined Diagnosis Related Group (APRDRG) severity data element: mild/moderate (minor or mild loss of function), major (major loss of function), and extreme (extreme loss of function).[15] Birthweight was categorized in three groups (<1500 grams, 1500-2499 grams and ≥2500 grams) by a step-wise process as described by Patrick et al.[18] We used birthweight data element from the KID. For records where birthweight was not reported, ICD-9-CM codes and APRDRG codes indicating birth weight were used (Table, Supplemental Digital Content 1).

Hospital Characteristics

Hospital characteristics included hospital teaching status (teaching or non-teaching), ownership (government or private), bed size (small, medium or large) and geographical region (as North East, South, Midwest or West). These definitions are provided in the KID introduction. [40]

Outcome Variables

Following outcomes were considered: in-hospital mortality, length of stay (LOS), and total costs. The KID reports hospital charges and using the HCUP Cost-to-Charge Ratio, all charges were converted to determine total cost. All costs were converted to 2012 US dollars using the consumer price index.[19]

Statistical Analysis

To have unbiased variance of national estimates, all statistical analyses accounted for survey design. All the patient level analyses included discharge level weight, hospital clustering, hospital stratification, and domain information. All patients have been weighted as is described in the KID introduction.[40] Categorical and continuous outcomes were compared to patient characteristics using chi-square and t-tests, respectively for unadjusted analyses. In-hospital mortality was summarized using proportions; LOS and total charges were described using mean and its standard error and median. Multivariable logistic regression was constructed to determine the association of patient and hospital characteristics with in-hospital mortality. Multivariable linear regression was used to determine association of patient and hospital characteristics with LOS and total hospital costs. All the values for cost are reported after inflation adjustment to 2012. During our multivariable analyses, we did not consider any hierarchy in our data set. All statistical analyses were performed using SAS 9.4 (SAS Institute Inc., Cary, North Carolina) with all the testing as 2-sided at level of significance (α) set at 0.05.

RESULTS

Our final cohort consisted of 116,882 unique discharges equivalent to weighted discharges of 160,667 (Figure 1). Table 1 describes cohort characteristics. Overall mortality due to neonatal sepsis was 3.29% (N=5,291). Mean LOS for all discharges were 21.0 days (SE, 0.36) and total economic cost for 2006, 2009, and 2012 was \$5.8 billion with a mean treatment cost of \$36,120 (SE, 870) per patient discharge.

Association of Patient and Hospital Characteristics with Mortality

Table 2 reports multivariable logistic regression results for in-hospital mortality. Among patient characteristics, insurance status, median household income level, severity of illness and birthweight were associated with in-hospital mortality. Neonates with self-pay insurance status had higher mortality odds (OR, 3.26; 95% CI 2.60-4.08) compared to private insurance. Low median household income was associated with increased odds of death: Q1 (OR, 1.19; 95% CI 1.05-1.35) and Q2 (OR, 1.14; 95% CI 1.01-1.29). Severity of illness was associated with substantial increased odds of death: Extreme severity of illness had an adjusted OR of 36.10 (95% CI 28.37-45.94) and major severity of illness had an OR of 9.78 (95% CI 7.90-12) compared to patients with mild/moderate severity. Neonates born less than 1500 grams had significantly increased odds of death (OR 4.80; 95% CI 4.06-5.56) compared to normal weight neonates (>2,500 grams). Neither race nor gender adversely affected mortality when adjusted for all other covariates.

Neonates born in a teaching hospital had an increased odds of death when compared to a non-teaching hospital. Similarly, large and medium sized hospitals had increased mortality, compared to small sized hospitals. Neither hospital ownership nor location had an adverse effect on mortality (Table 2).

Adjusted Association of Patient and Hospital Characteristics with Length of Stay (LOS)

Table 3 reports the adjusted multiple linear regression analyses for LOS. Black patients had a decreased LOS compared to White patients. Medicaid patients had significantly increased LOS, while self-pay patients had a decreased LOS when compared to patients with private insurance. Extreme severity of illness was highly associated with increased LOS of 29 days and major severity of illness had increased LOS of 8 days compared to mild/moderate severity of illness. Similarly, neonates with birth weight <1500 g had an increased LOS of 38 days and neonates with birth weight of 1500-2499 g had an increased LOS of 9 days when compared to normal birth weight neonates.

Hospital characteristics associated with differences in LOS included hospital teaching status, hospital ownership and hospital size. (Table 3)

Adjusted Association of Patient and Hospital Characteristics with Treatment Cost

Table 4 shows the adjusted multiple linear regression analyses for treatment cost. Hispanic patients had significantly increased cost compared to White patients. Medicaid patients had significantly increased treatment cost while self-pay patients had a decreased treatment cost when compared with patients with private insurance. Extreme severity of illness was associated with increased treatment cost of \$76,312.76 and major severity of illness had increased cost of \$14,871.77 when compared to mild/moderate severity of illness. Similarly, neonates with birth weight <1500 g had an increased cost of \$65,688.37 and neonates with birth weight of 1500-2499 g had an increased cost of \$12,447.87 when compared to neonates with a normal birth weight.

Patients born in a teaching hospital had increased treatment costs. While government owned hospitals were associated with a significantly decreased treatment cost. Similarly, hospitals located in the Southern and Midwestern US were associated with significantly decreased treatment costs.

DISCUSSION

Neonatal sepsis is a significant contributor to overall infant and child mortality.[20] The data presented here demonstrate that socioeconomic and healthcare access disparities contribute significantly to neonatal mortality and healthcare resource utilization. Self-pay insurance status, lower median household income, low birth weight, and severity of illness increased the odds of death significantly. Additionally, Blacks and self-pay patients had shorter LOS compared to Whites and patients with private insurance.

Furthermore, increased costs to the healthcare system were seen in Hispanic patients, patients with Medicaid, and with increased severity of illness. It is important to remember that cost and LOS are not independent variables, as increased LOS will contribute

significantly to costs. Globally, neonatal mortality rates due to sepsis are increased in low and low-middle income countries as compared to the highest income countries. Importantly though, as these countries have improved their socioeconomic status and have received economic support, their U5MR has dramatically improved over the course of the MGD-4 timeline.[1]

The US ranks 26th in infant mortality among the Organisation for Economic Co-operation and Development countries[21] and last in the rate of preterm births among industrialized countries.[22] However, cross-country neonatal mortality comparisons must be interpreted carefully due to live-births reporting differences and discrepancies in the threshold of viability among nations. A recent study demonstrated that the neonatal mortality is similar in the United States and European countries when accounting for birth weight, a surrogate of health at birth.[23] The authors also demonstrated that geographic variations in post neonatal mortality are attributable to socioeconomic gradients, either within regions of the same country or across nations. The lack of such association in neonatal mortality led the authors to suggest that inequalities grow stronger during the postnatal period.[23]

Neonatal sepsis is usually not an isolated event and is associated with other perinatal factors. Preterm birth complications and complications during labor account for 36% and 23% of global neonatal deaths, respectively.[24] Moreover, in the US, preterm birth complications account for about two-thirds of all deaths and is markedly higher among underprivileged women.[25,26] These events are correlated with low socioeconomic status and diminished access to healthcare. Indeed, in a large systematic review, socioeconomic disparities were associated with adverse birth outcomes in 93 of 106 studies.[27] States with the worst economic factors, such as high rates of poverty, high unemployment rates, and lower graduation rates have significantly higher mortality rates than other less disadvantaged states (1.18 excess deaths per 1000 live births).[28] These States are mostly located in the Southern US and it has been proposed that a possible reason for such disparity is the overall larger proportion of Black births that account for 60% of the regional disparity.[22,28,29] The mortality rate of Black infants in the US has increased from 1.6 to 2.4 times that of whites from the 1950s to 2005.[30] In neonatal sepsis, race is used as a surrogate for other sociodemographic disparities such as: decreased prenatal care, adverse living conditions, poverty, young maternal age, and poor access to care.[14] Indeed, our nationally represented study of neonatal sepsis had similar socioeconomic findings. Twenty-six percent of Black neonates were born with very low birth weight compared to 16% in White neonates ($p<0.0001$, Figure A, Supplemental Digital Content 2). Black patients were more likely to be from the poorest income quartile (48% vs 21%, $p<0.0001$) when compared to White patients (Figure B, Supplemental Digital Content 2). These results suggest that although in the adjusted model race was not a significant contributor to mortality it may be a marker for poverty and/or lack of healthcare access for the mother.

LaViest et al. studied the economic burden of racial disparities in adults and found an association with significant annual economic losses. The group reported an estimated \$35 billion in excess health care expenditure, \$10 billion in lost productivity, and most notably \$200 billion in premature deaths. Approximately \$136 billion and \$82 billion were attributed to excess medical costs among Blacks and Hispanics, respectively.[31] Although a

similar study in the pediatric population has not been performed, the economic impact of health disparities in children has been studied in specific diseases or conditions[32]. Bilaver et al. found that children from low-income families incurred 2.5 times more on emergency room and hospitalization costs compared to children from high-income families.[33] Xu et al. reported that racial disparities account for approximately \$329 million associated with excess preterm births in Blacks during 2003 in the state of Michigan.[34] To the best of our knowledge, this is the first study to report the economic burden associated with neonatal sepsis at a national level. Our analysis shows an estimate of \$5.8 billion spent in the treatment cost of neonatal sepsis in the three years studied. This noticeable amount does not include associated economic losses such as long-term financial impact of neonatal mortality, potential declines in parent productivity, and post-discharge treatment costs.

Insurance status has been associated with differences in cost and LOS in the pediatric population. Berry et al. showed that publicly insured children requiring inpatient treatment of bipolar disorder had a longer hospital stay and higher costs than privately insured patients. [35] Pati et al evaluated the impact of insurance status on LOS in children hospitalized with community-acquired pneumonia. The study included national admissions over a nine-year period and found that publicly insured children have higher LOS even after accounting for severity of disease.[36] Similar associations between increased LOS and publicly insured pediatric patients have been reported in other infectious and non-infectious conditions. [37,38] Similarly, our study showed increased length of stay in publicly-insured patients. In addition to patient and socioeconomic factors, hospital- and system-level characteristics (e.g., availability and use of ancillary services, and post-discharge care) can potentially impact LOS.[39,40]

Neonatal sepsis mortality is a significant contributor to neonatal mortality in the US. Factors related to mortality are most likely occurring prior to birth and not associated with care received once diagnosed although this is difficult to elucidate. Inadequate prenatal care, poor health status of the mother, un- or underinsured mothers, and even racial discrimination leading to traumatic and stressful environments are major factors affecting neonatal survival. [41] Sepsis recognition and urgent treatment are paramount to survival, but the main message of this study is that a robust public health campaign addressing income inequality and access to health care should be studied.

Administrative databases such as the KID are useful for giving national estimates. However, our study had several limitations, including the potential of information and sampling biases, which are inherent to our data source. Due to our study observational design, we were unable to determine if the studied associations are directly causing the observed differences in outcomes. As mentioned, the KID does not represent a complete record of all pediatric discharges in the US. Further, the data for each discharge varies from record to record. For example gestational age was a poorly represented variable in our data set and we used birth weight as a surrogate for gestational age. In addition, the database does not contain maternal elements (age, comorbid conditions, and pregnancy complications) and is limited in the extent and detail of social determinants.

CONCLUSIONS

This national study on neonatal sepsis provides significant insight into the contributing factors associated with increased neonatal sepsis mortality and resource utilization. Moreover, it provides specific targets to address as a society to reduce neonatal sepsis mortality in the United States. “A world in which there are no preventable deaths of newborns or stillbirths, where every pregnancy is wanted, every birth celebrated, and women, babies, and children survive, thrive and reach their full potential,” is the vision statement for the Every Newborn Action Plan and should drive our endeavors to address these continued preventable deaths.[42]

Acknowledgments

This work was supported by the National Institutes of Health T32-GM8256 (FJB). We would like to thank Dr. Claire Cummins for her editorial assistance and all of the HCUP Data Partners that contribute to HCUP: Alaska, Arizona, Arkansas, California, Colorado, Connecticut, District of Columbia, Florida, Georgia, Hawaii, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, New York, North Carolina, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia, Wisconsin, Wyoming. We would also like to thank Karen Martin for her generous help in preparing our data for publication.

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Figure 1. Unweighted Cohort Development Using KID for years 2006, 2009, and 2012

Schematic representation of cohort creation approach following a multi-step process.

Neonatal discharges were determined by age at admission, neonate indicator variable, and by any diagnosis code representing an in-hospital birth and without an admission source from another healthcare facility or home. Neonates with sepsis were identified using ICD-9-CM codes. We excluded patients who were (i) transferred in or came from home after birth,

(ii) transferred out of the hospital to another acute care facility, or (iii) missing patient or hospital characteristics.

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Table 1

Cohort Characteristics

Characteristics	Sepsis Unweighted=116,882 Weighted=160,667	Mortality Weighted row % (SE)	Treatment cost (CI) [#]	Length of stay (CI)
	Weighted % (SE) [*]			
Patient characteristics				
<i>Race/Ethnicity</i>				
White	43.2(0.95)	3.0(0.12)	33.9(32.1-35.8)	20.4(19.6-21.2)
Black	20.1(0.77)	4.8(0.21)	41.4(38.5-44.3)	25.0(23.6-26.4)
Hispanic	25.8(0.99)	2.6(0.15)	35.3(33.1-37.6)	19.4(18.6-22.2)
Other	11.0(0.41)	3.1(0.21)	36.9(34.0-39.8)	20.1(19.1-21.1)
<i>Sex</i>				
Male	56.1(0.16)	3.3(0.12)	35.3(33.7-36.9)	20.4(19.7-21.1)
Female	43.9(0.16)	3.3(0.13)	37.2(35.4-39.1)	21.8(21.1-22.6)
<i>Primary payer</i>				
Medicaid	53.3(0.85)	3.05(0.12)	37.1(35.0-39.2)	21.9(21.0-22.7)
Private	40.1(0.88)	2.71(0.11)	35.7(33.9-37.5)	20.5(19.8-21.2)
Self-pay	3.2(0.19)	3.9(0.38)	16.6(14.7-18.4)	11.4(10.7-12.2)
Other	3.5(0.28)	3.22(0.21)	44.6(37.1-52.1)	22.6(20.5-24.7)
<i>Median Household Income^{**}</i>				
Q1	31.7(0.99)	3.8(0.16)	36.7(34.3-39.1)	21.9(20.9-22.9)
Q2	23.8(0.56)	3.6(0.18)	36.1(34.1-38.1)	21.3(20.4-21.2)
Q3	24.1(0.46)	3.0(0.15)	35.2(33.4-37.0)	20.4(19.6-21.2)
Q4	20.3(0.87)	2.8(0.14)	36.3(34.0-38.6)	21.1(19.3-21.0)
<i>APR-DRG Severity</i>				
Mild/Moderate	63.1(0.63)	0.2(0.02)	11.7(11.2-12.3)	9.1(8.9-9.2)
Major	22.9(0.36)	3.4(0.14)	45.7(43.8-47.6)	28.0(27.8-29.2)
Extreme	14.1(0.40)	17.1(0.45)	130.1(125.2-134.9)	62.6(61.1-64.1)
<i>Birth weight (grams)</i>				
<1500	17.4(0.43)	15.1(0.37)	120.4(116.2-124.6)	63.7(62.6-64.9)
1500-2499	23.9(0.29)	1.2(0.08)	30.4(29.1-31.7)	21.2(19.7-20.6)
2500	58.7(0.53)	0.7(0.04)	13.4(12.8-14.1)	8.7(8.5-8.9)
Hospital characteristics				
<i>Teaching</i>				
Yes	54.3(1.63)	4.5(0.19)	47.5(44.6-50.3)	25.9(24.7-27.0)
No	45.7(1.43)	1.8(0.10)	22.6(20.9-24.3)	15.3(14.5-16.0)
<i>Hospital ownership</i>				
Government	50.7(1.67)	3.9(0.19)	40.9(38.1-43.7)	23.0(21.8-24.2)
Private	49.3(1.66)	2.6(0.12)	31.3(29.3-32.2)	19.0(18.3-19.7)
<i>Hospital bed size</i>				

Characteristics	Sepsis Unweighted=116,882 Weighted=160,667	Mortality Weighted row % (SE)	Treatment cost (CI) [#]	Length of stay (CI)
	Weighted % (SE) [*]			
Small	6.1(0.62)	1.4(0.19)	24.6(18.1-31.0)	14.9(12.6-17.3)
Medium	23.3(1.34)	2.5(0.15)	29.8(26.9-32.7)	17.9(17.0-18.9)
Large	70.7(1.43)	3.7(0.16)	39.2(37.0-41.4)	22.6(21.7-23.5)
<i>Hospital regions</i>				
Northeast	18.6(1.39)	3.6(0.26)	42.2(36.6-47.8)	21.6(19.7-23.5)
Midwest	13.1(0.89)	3.4(0.37)	37.4(33.6-41.2)	22.2(20.4-24.0)
South	45.4(1.67)	3.6 (0.18)	32.5(30.1-35.0)	21.9(20.9-22.9)
West	22.9(0.05)	2.5(0.20)	37.6(34.5-40.7)	18.1(17.1-19.1)

^{*} : Standard error

[#] : 2012 Consumer Price Indexed adjusted cost in (x \$1000)

^{**} : 2006: Q1: \$1-37,999, Q2: \$38,000-46,999, Q3: \$47,000-61,999, Q4: > \$62,000
 2009: Q1: \$1-39,999, Q2: \$40,000-49,999, Q3: \$50,000-65,999, Q4: > \$66,000
 2012: Q1: \$1-38,999, Q2: \$39,000-47,999, Q3: \$48,000-62,999, Q4: > \$63,000

Table 2

Multivariable Logistic Regression for Inpatient Mortality

Patient Characteristics	OR	95% CI
<i>Race</i>		
Black	1.10	0.99-1.21
Hispanic	0.93	0.84-1.04
White	Reference	
<i>Gender</i>		
Female	0.94	0.87-1.01
Male	Reference	
<i>Primary Payer</i>		
Medicaid	1.02	0.93-1.21
Self-Pay	3.26	2.60-4.08
Private	Reference	
<i>Median Household Income*</i>		
Q1	1.19	1.05-1.35
Q2	1.14	1.01-1.29
Q3	1.06	0.94-1.19
Q4	Reference	
<i>APR-DRG Severity</i>		
Mild-Moderate	Reference	
Major	9.78	7.90-12.12
Extreme	36.10	28.37-45.94
<i>Birth Weight (g)</i>		
<1500 g	4.80	4.06-5.66
1500-2499 g	1.14	0.97-1.34
>2500 g	Reference	
<i>Hospital Characteristics</i>		
<i>Teaching Status</i>		
Non-teaching	Reference	
Teaching	1.35	1.18-1.54
<i>Hospital Ownership</i>		
Government	0.90	0.80-1.01
Private	Reference	
<i>Bed Size</i>		
Small	Reference	
Medium	1.42	1.10-1.84
Large	1.68	1.32-2.13
<i>Location</i>		

Patient Characteristics	OR	95% CI
North East	0.95	0.80-1.13
Midwest	0.91	0.74-1.12
South	1.00	0.87-1.15
West	Reference	

*
: 2006: Q1: \$1-37,999, Q2: \$38,000-46,999, Q3: \$47,000-61,999, Q4: > \$62,000
2009: Q1: \$1-39,999, Q2: \$40,000-49,999, Q3: \$50,000-65,999, Q4: > \$66,000
2012: Q1: \$1-38,999, Q2: \$39,000-47,999, Q3: \$48,000-62,999, Q4: > \$63,000

Table 3

Multivariable Linear Regression for Length of Stay

Patient Characteristics	Estimated Regression Coefficients (Days)	Standard Error	P-value
<i>Race</i>			
Black	−0.86	0.25	0.0005
Hispanic	0.21	0.22	0.34
White	Reference		
<i>Gender</i>			
Female	0.04	0.11	0.69
Male	Reference		
<i>Primary Payer</i>			
Medicaid	1.15	0.16	<0.0001
Self-Pay	−2.49	0.31	<0.0001
Private	Reference		
<i>Median Household Income*</i>			
Q1	0.02	0.28	0.96
Q2	0.37	0.25	0.14
Q3	0.10	0.21	0.61
Q4	Reference		
<i>APR-DRG Severity</i>			
Mild-Moderate	Reference		
Major	7.91	0.19	<0.0001
Extreme	29.19	0.57	<0.0001
<i>Birth Weight (g)</i>			
<1500 g	38.45	0.41	<0.0001
1500-2499 g	9.23	0.14	<0.0001
>2500 g	Reference		
<i>Hospital Characteristics</i>			
<i>Teaching Status</i>			
Non-teaching	Reference		
Teaching	3.28	0.27	<0.0001
<i>Hospital Ownership</i>			
Government	−1.92	0.31	<0.0001
Private	Reference		
<i>Bed Size</i>			
Small	Reference		
Medium	−0.09	0.38	0.81
Large	1.80	0.33	<0.0001
<i>Location</i>			
North East	−0.39	0.41	0.34

Patient Characteristics	Estimated Regression Coefficients (Days)	Standard Error	P-value
Midwest	0.74	0.39	0.06
South	0.00	0.30	0.99
West	Reference		

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Table 4

Multivariable Linear Regression for Treatment Cost

Patient Characteristics	Estimated Regression Coefficients (2012 US Dollars)	Standard Error	P-value
<i>Race</i>			
Black	-1451.56	783.47	0.06
Hispanic	3067.21	749.02	<0.0001
White	Reference		
<i>Gender</i>			
Female	-250.34	258.83	0.33
Male	Reference		
<i>Primary Payer</i>			
Medicaid	1504.18	560.87	0.007
Self-Pay	-5015.50	782.15	<0.0001
Private	Reference		
<i>Median Household Income*</i>			
Q1	-1813.41	936.13	0.05
Q2	-707.45	774.56	0.36
Q3	-1231.11	628.52	0.05
Q4	Reference		
<i>APR-DRG Severity</i>			
Mild-Moderate	Reference		
Major	14871.77	528.57	<0.0001
Extreme	76312.76	1848.66	<0.0001
<i>Birth Weight (g)</i>			
<1500 g	65688.37	1416.84	<0.0001
1500-2499 g	12447.87	403.19	<0.0001
>2500 g	Reference		
<i>Hospital Characteristics</i>			
<i>Teaching Status</i>			
Non-teaching	Reference		
Teaching	9853.76	1059.44	<0.0001
<i>Hospital Ownership</i>			
Government	-4778.23	1302.73	0.0002
Private	Reference		
<i>Bed Size</i>			
Small	Reference		
Medium	12.89	2189.46	0.99
Large	3371.77	2033.23	0.1
<i>Location</i>			

Patient Characteristics	Estimated Regression Coefficients (2012 US Dollars)	Standard Error	P-value
North East	-2838.06	2116.62	0.18
Midwest	-6117.51	1458.05	<0.0001
South	-11701.81	1370.82	<0.0001
West	Reference		

*
: 2006: Q1: \$1-37,999, Q2: \$38,000-46,999, Q3: \$47,000-61,999, Q4: > \$62,000
2009: Q1: \$1-39,999, Q2: \$40,000-49,999, Q3: \$50,000-65,999, Q4: > \$66,000
2012: Q1: \$1-38,999, Q2: \$39,000-47,999, Q3: \$48,000-62,999, Q4: > \$63,000